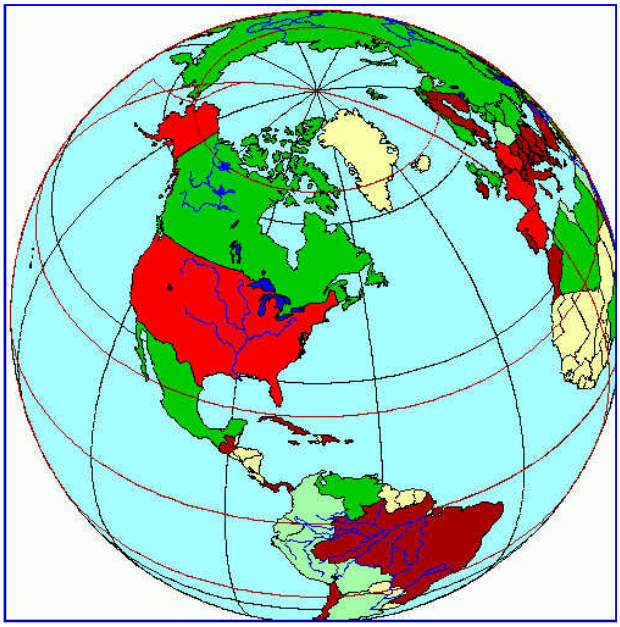
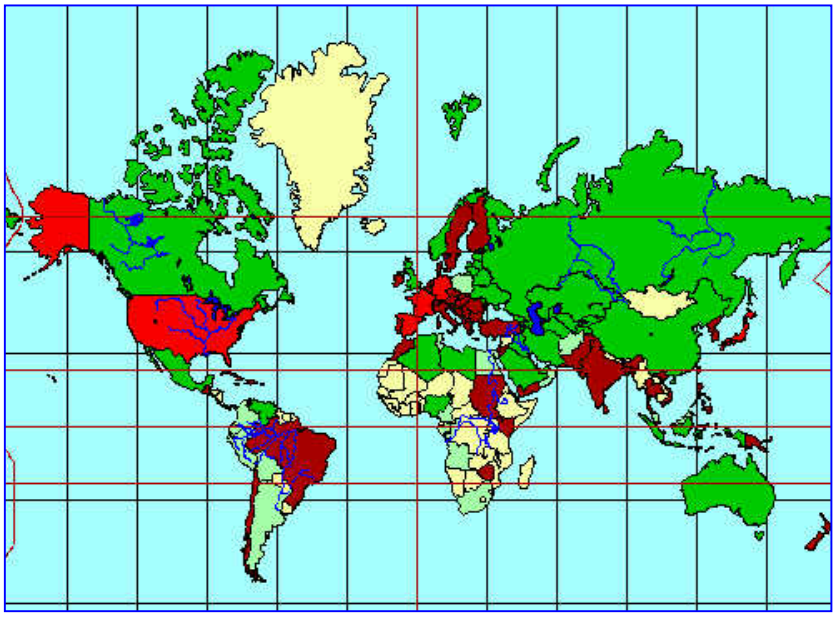
Coordinate Referencing Systems



Locations on the globe are measured in degrees of latitude and longitude.

Locations on a map are measured using x and y coordinates.

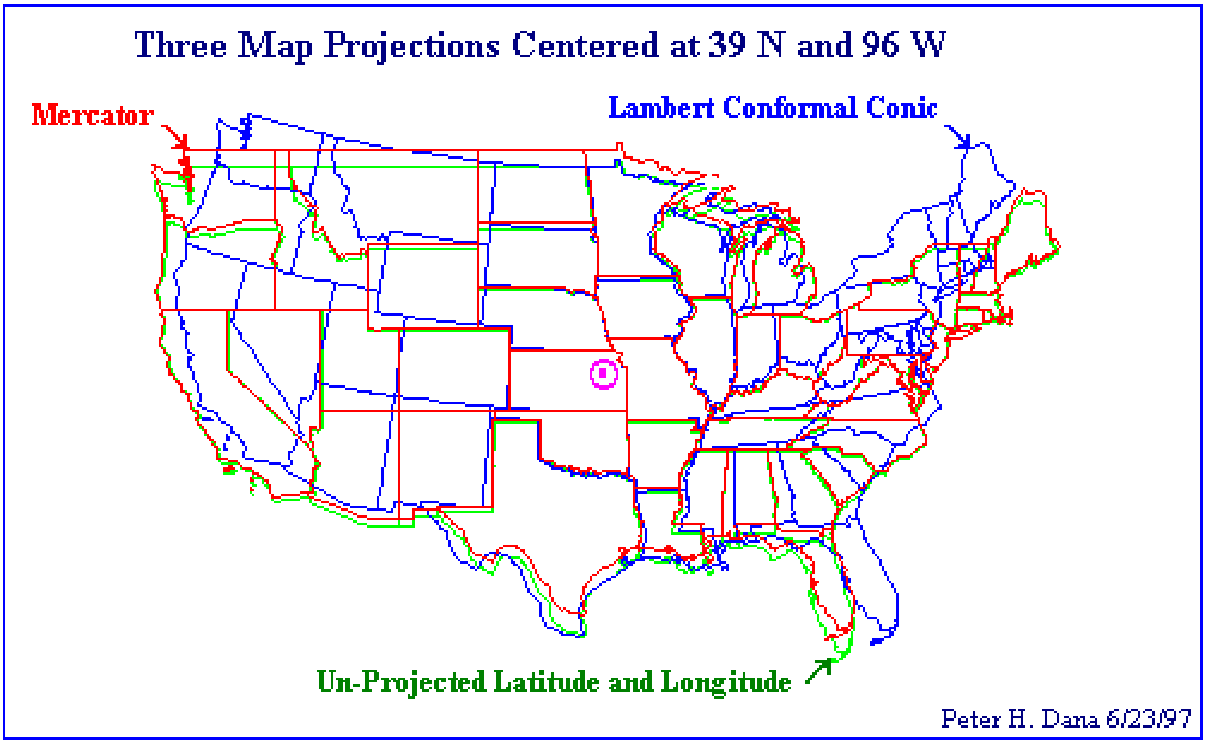


A **map projection** converts locations on earth's curved surface to locations on a flat map.

Map Projections

Map projections and geographic coordinate grids affect the position of map details. When you are using spatially referenced data in GIS, you need to know what projection was used for creating the data and what projection is used for displaying the data. If needed, you can mix and match data from different projections for display if you first convert the data (understanding that there will be some distortion).

If you try to layer spatial data from different projections that have not been converted, the map details on one map layer will have no relationship with another map layer. The following example shows three coordinate systems used to project the image of the United States, all anchored at a point in Kansas. If Cities or Roads are in one projection and the State Map is in another you could end up with Cities in the wrong states and Roads in the oceans.

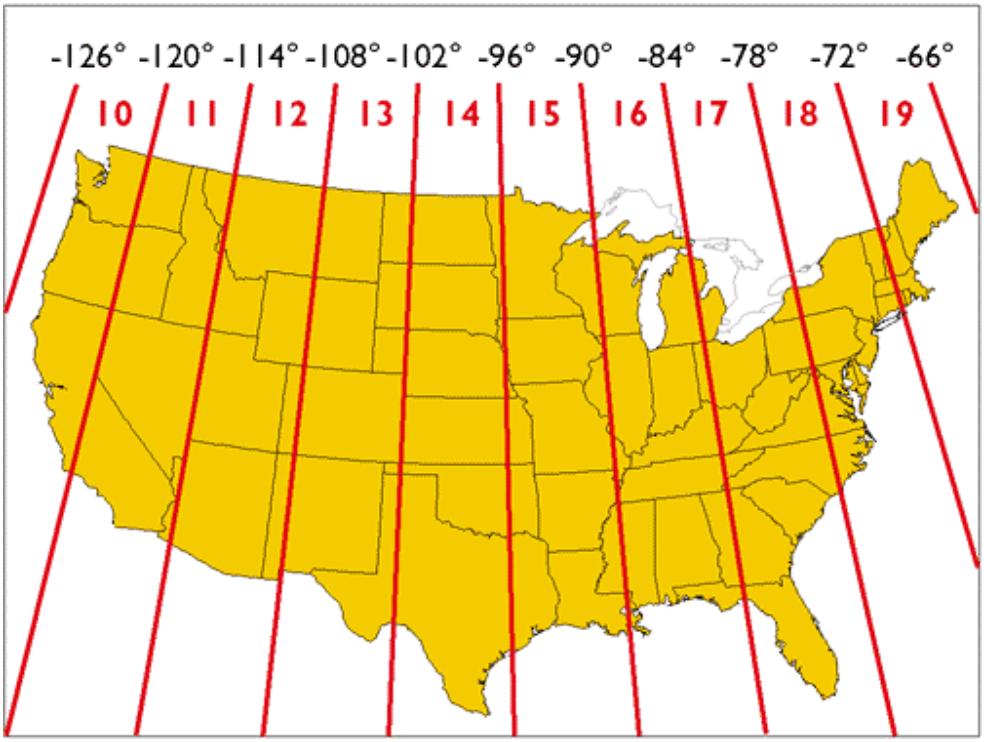


All printed maps should display the map projection in the margin area. All spatial data stored in a GIS system should also have accompanying metadata that describes data creation methods, reliability of the data, and sources for information used in development of the data. Be careful mixing and matching GIS data.

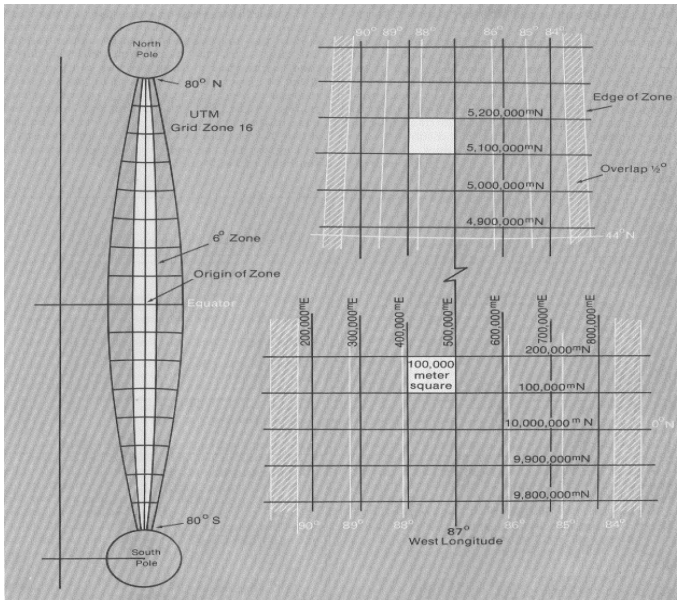
Universal Transverse Mercator (UTM) Map Projection
(Standard Projection for Toolkit)

The UTM system was developed by the US Army Map Service after World War II. There are 60 UTM zones, each 6° wide and covering from 80° South to 84° North (the Poles are covered by a different system). The zones are numbered from 1 to 60, with zone 1 starting at 180° to 174° West and continuing to the east.

UTM Zones of the Unites States



The two reference lines for the square grid system in each zone are the Equator and the Central longitude meridian of each zone (177° in zone 1), which is the base line for the transverse Mercator projection.

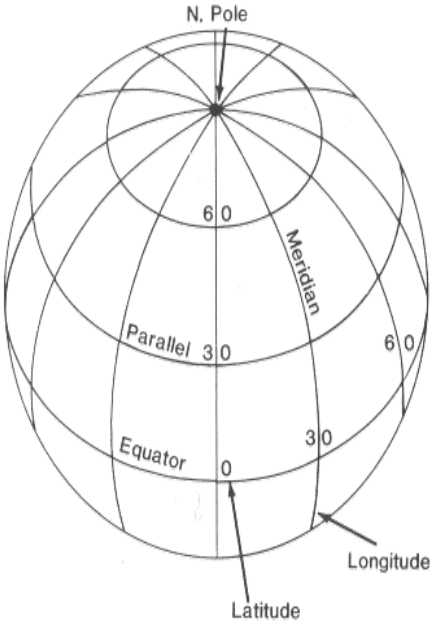


Within a zone, there are two coordinates: an Easting and a Northing. The East number is the distance in meters along a line perpendicular to the central meridian and passing through a given point, where the central meridian is assigned a value of 500,000 meters. The North number is the distance in meters from the Equator to where the perpendicular line above crosses the central meridian.

UTM coordinates, then, consist of an easting (in meters), a northing (in meters), and a zone number.

Latitude and Longitude
Geographic Coordinate System

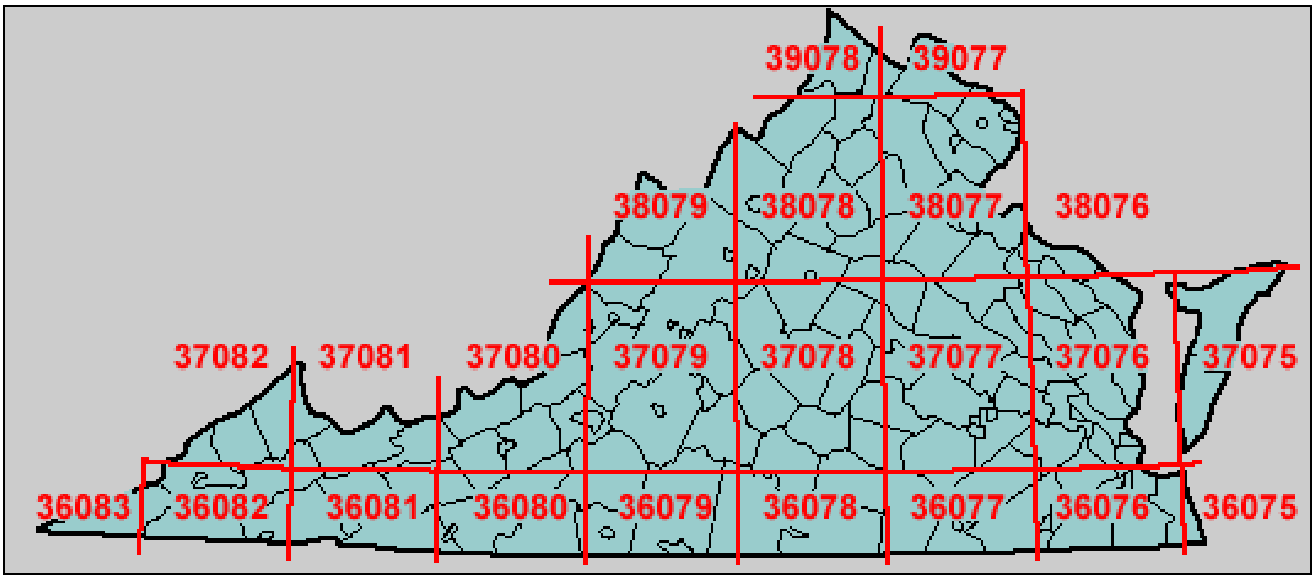
Latitude is a measure of the angular distance north or south of the Equator. The Equator is at 0° latitude while the North Pole is at 90° North latitude. Latitude lines are parallel to the Equator.



Longitude is the angular distance east or west of the Prime Meridian, which runs from the North Pole to the South Pole and through the town of Greenwich, England.

Both latitude and longitude are listed in degrees, minutes, and seconds. (Minutes and seconds are part of degrees, just as feet and inches are parts of a mile.) There are 60 minutes in 1 degree and 60 seconds in 1 minute.

1-degree by 1-degree units in Virginia



For every 1 degree by 1 degree unit, there are 64 7.5 minute units.

On every 7.5 minute topoquad, there are tic marks around the margins every 2.5 minutes *(designated by a black line on the inside of the map area).*

3 Coordinate Systems are on each 7.5 Minute USGS Topoquad

- Universal Transverse Mercator (UTM)
- Latitude/Longitude
- State Plane Coordinate System (SPCS)

As an example, here is a description of the UTM and Lat-Long grid tic marks on the Petersburg, Virginia 7.5 Minute Topoquad

The Petersburg Quad is in Zone 18, in 1,000 meter **UTM** grid tics
(UTM grid tics are the thin blue lines on the outside edge of the map)

Looking at the bottom right corner, and then going up the right margin, there is a small blue tic line by the number $^{41}12^{000}$m N. Then about every 1-1/2" there is another reference by a blue grid mark that goes North 1,000 meters. The next one is abbreviated $^{41}13$ and on up to $^{41}25$ which is 4,125,000 m North. There are matching grid tic marks on the left margin *(although you'll notice they are not straight across).*

Going across the bottom, starting on the left at around 278,000 meters E ($^{2}78$), and then about every 1-3/4" to the right it increases 1,000 meters, $^{2}79$, $^{2}80$, on up to $^{2}88^{000}$ meters East. Matching grid tic marks are along the top edge as well.

Lat-Long grid tics *(which are black tic marks pointing into the map area)* are also on every USGS topoquad. On the Petersburg Topoquad, the bottom right corner displays Latitude as 37°07'30" (north) and the Longitude as 77°22'30" (west). If you connected the 2.5 minute tic marks you would see there are 9 2.5 minute rectangles on the quad *(notice that these lines are straight).*